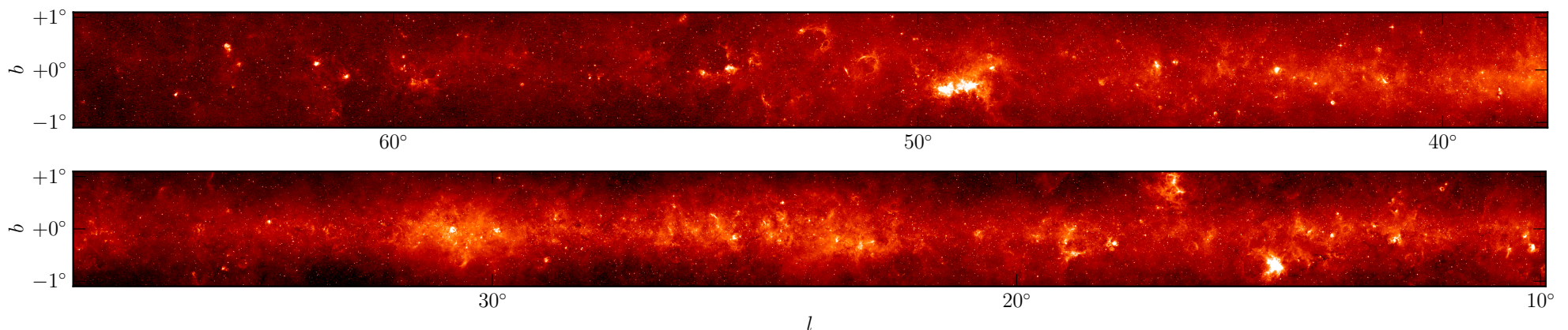


# The Luminosity Functions and Timescales of Massive YSOs and Ultra-Compact HII regions

Joe Mottram, University of Exeter, UK



## Red MSX Source (RMS) Survey Team

U. of Leeds, UK: Melvin Hoare, Rene Oudmaijer, Stuart Lumsden, Cormac Purcell, Hugh Wheelwright, Heather Cooper  
Rochester Institute of Technology, USA: Ben Davies  
ATNF, Australia: James Urquhart  
Liverpool JMU, UK: Toby Moore

# Massive Young Stellar Objects

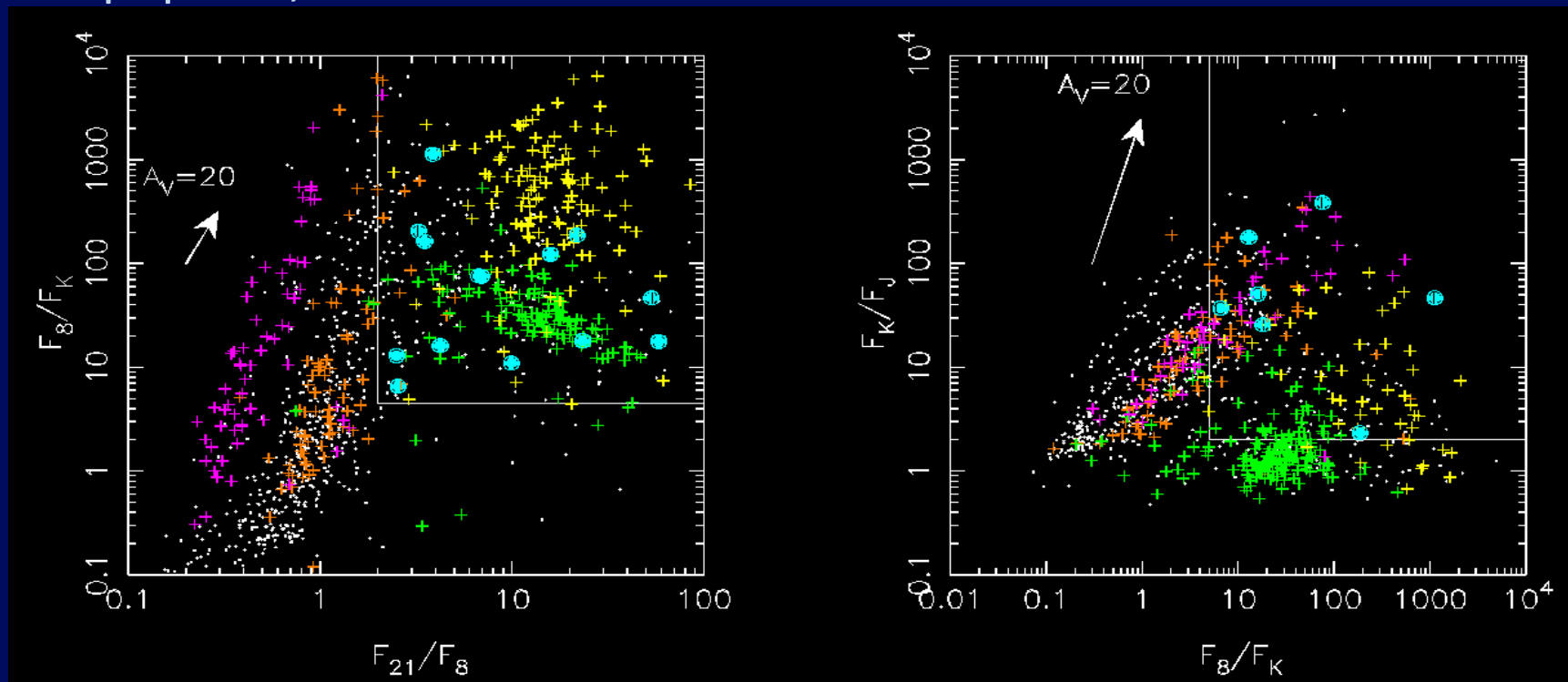
- Luminous ( $L > 10^4 L_{\odot}$ ) embedded mid-IR bright sources
- No HII region but sometimes ionised 'wind' (emission lines have  $v \sim 100$  km/s)
- Also frequently:
  - Supersonic molecular outflow
  - Maser emission



GL2591, Gemini JHK

# The Red MSX Source Survey

- Colour-selected  $\sim 2000$  candidates using MSX and 2MASS (Lumsden et al., 2002)
- $|b| \leq 5^\circ, 10^\circ \leq l \leq 350^\circ$

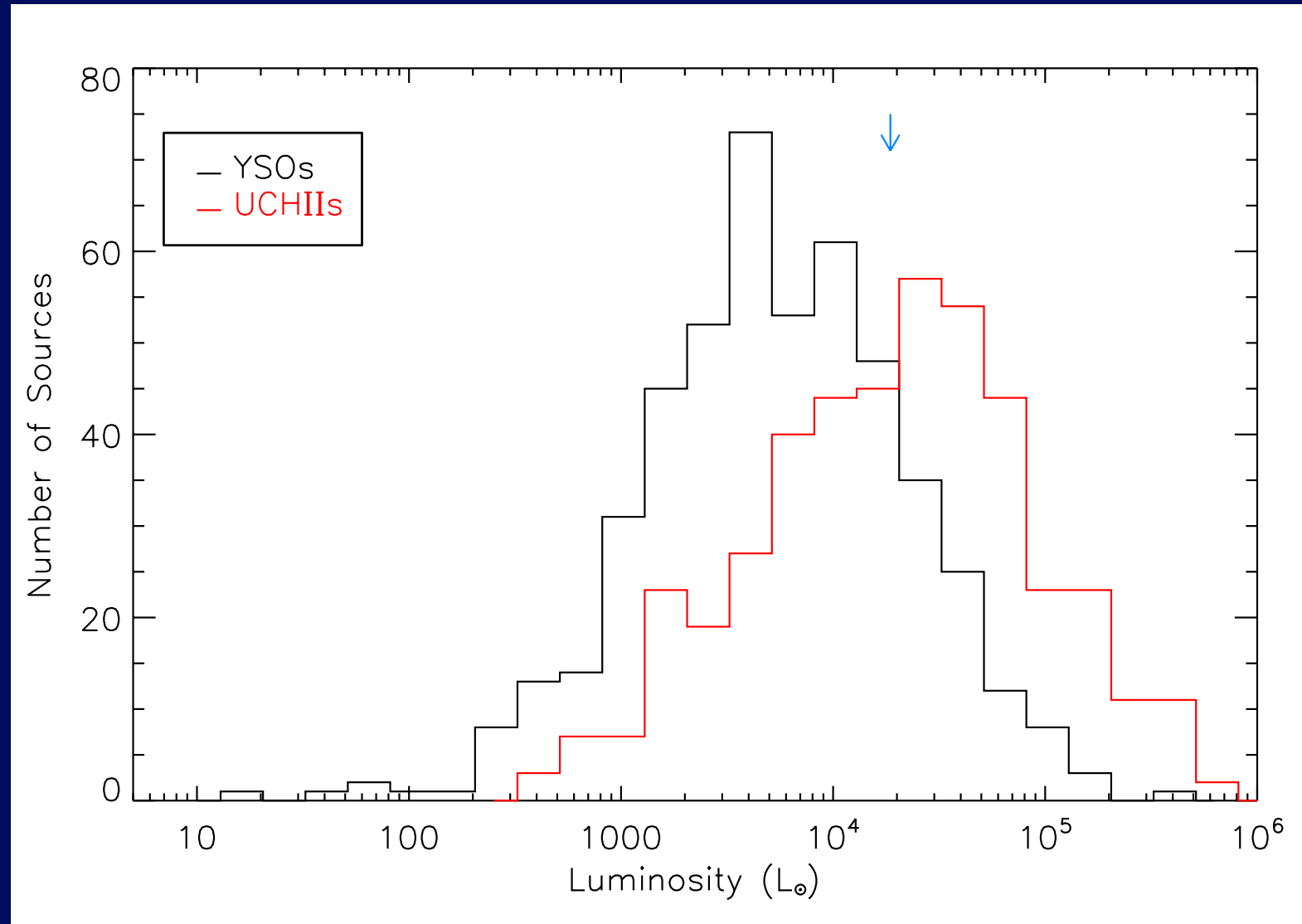


- Massive YSOs + UCHII regions + PN + C stars + OH/IR stars

# Follow-up of Sample

- $\sim 1''$  resolution radio continuum (Urquhart et al. 2007, 2009) => HII regions & PN
- $\sim 1''$  resolution mid-IR (Mottram et al 2007) => dust morphology (MYSOs vs HII regions)
- $^{13}\text{CO}$  & HI (Urquhart et al. 2007, 2008, 2010) => distances
- Spitzer MIPS GAL and IRAS IGA => Far-IR Flux => SEDs, Luminosities (Mottram et al 2010a, b)
- NIR spectroscopy (Cooper et al in prep) => final class and characterisation
- Data available at <http://www.ast.leeds.ac.uk/RMS/>

# The Luminosity Distributions



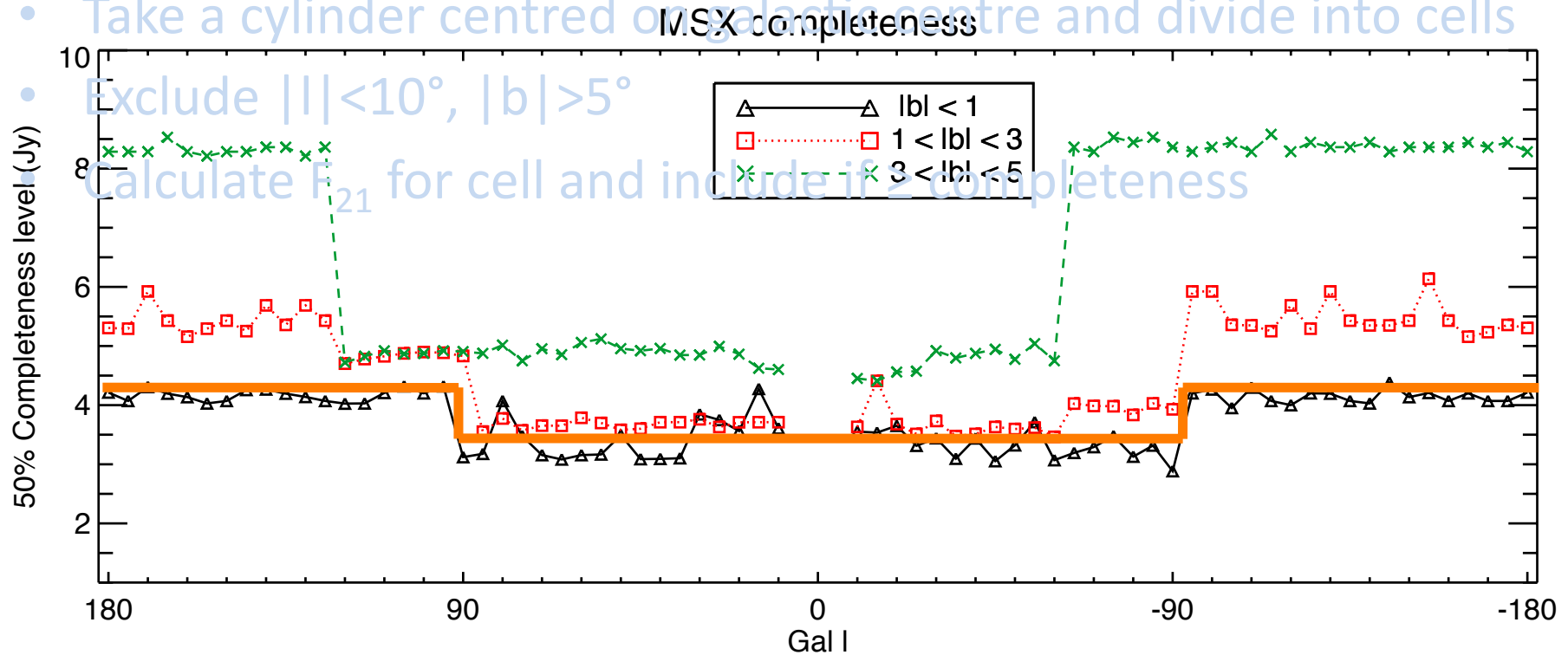
# Obtaining the Luminosity Function

- Need Volume observed as a function of L

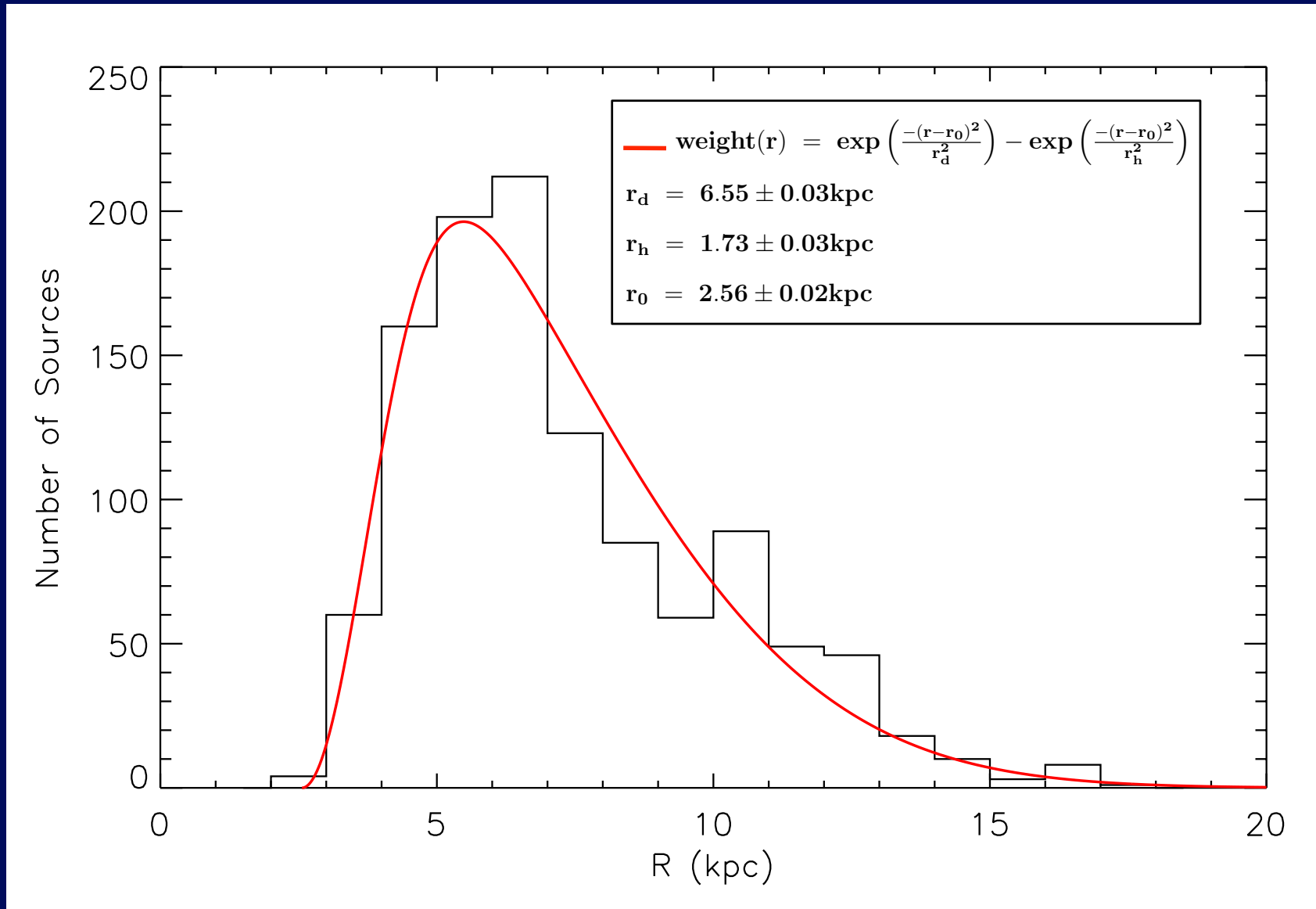
- Take a cylinder centred on galactic centre and divide into cells

- Exclude  $|l| < 10^\circ$ ,  $|b| > 5^\circ$

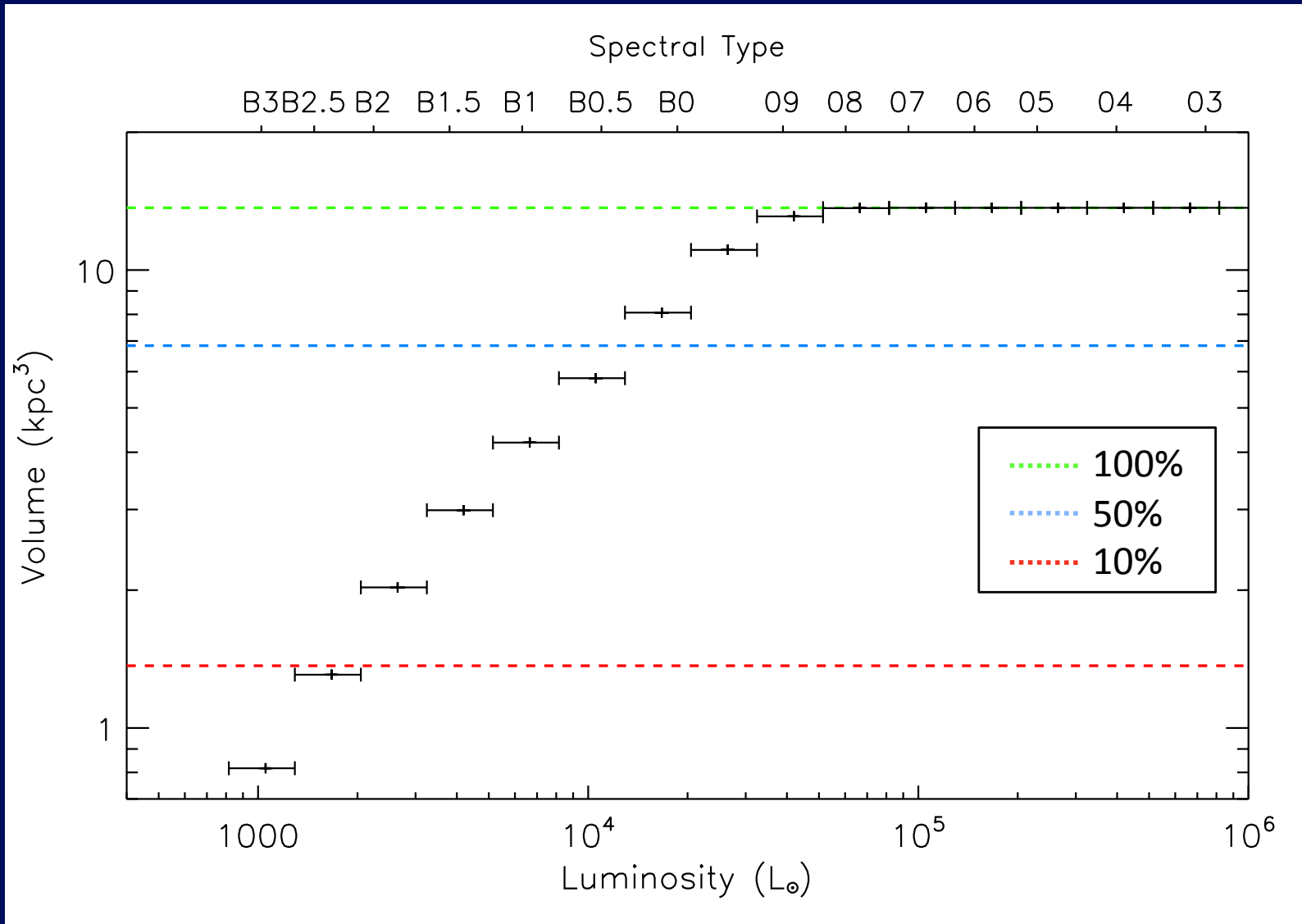
- Calculate  $F_{21}$  for cell and include if  $\geq$  completeness



# Weighting Function

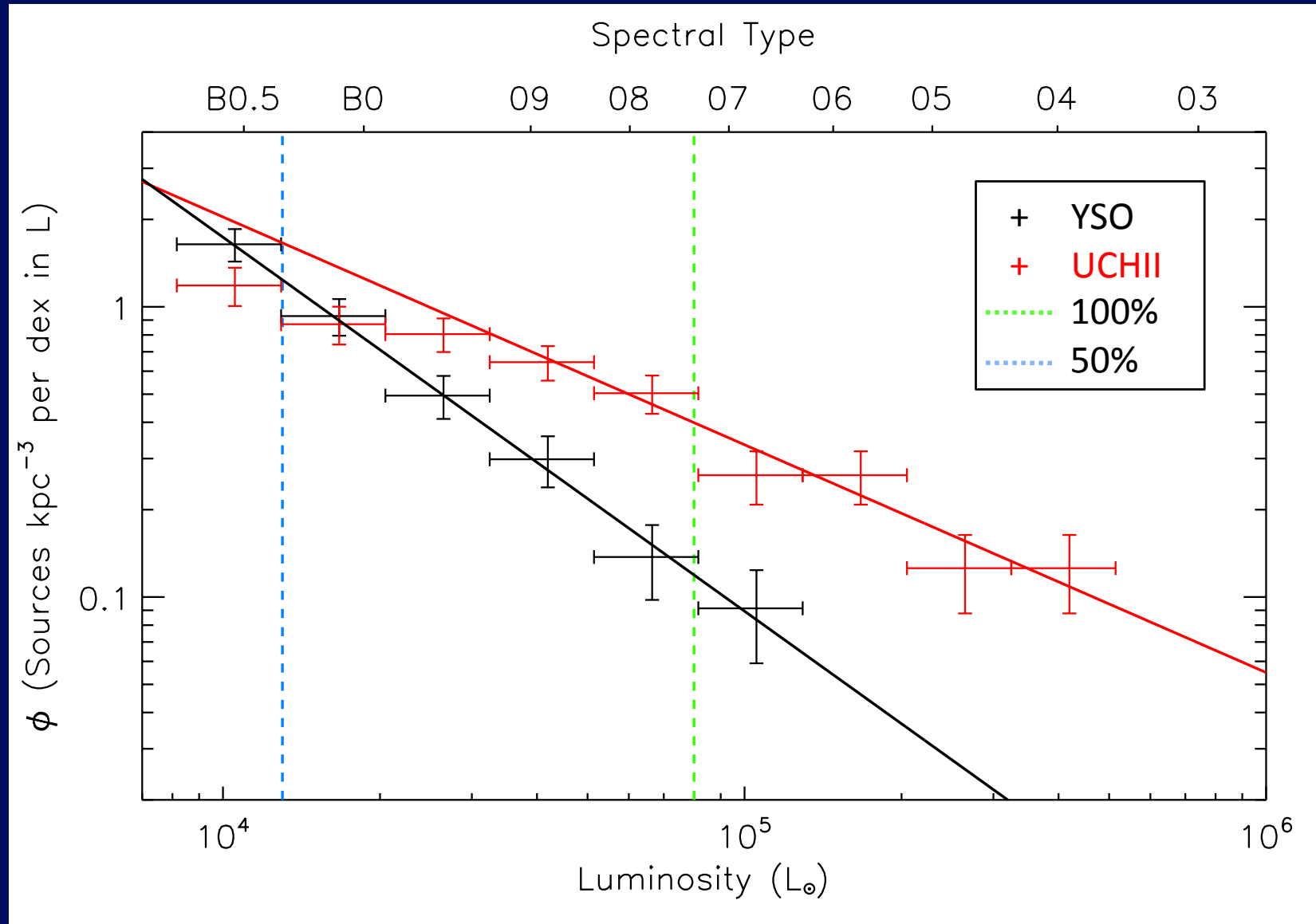


# Volume of the Galaxy observed

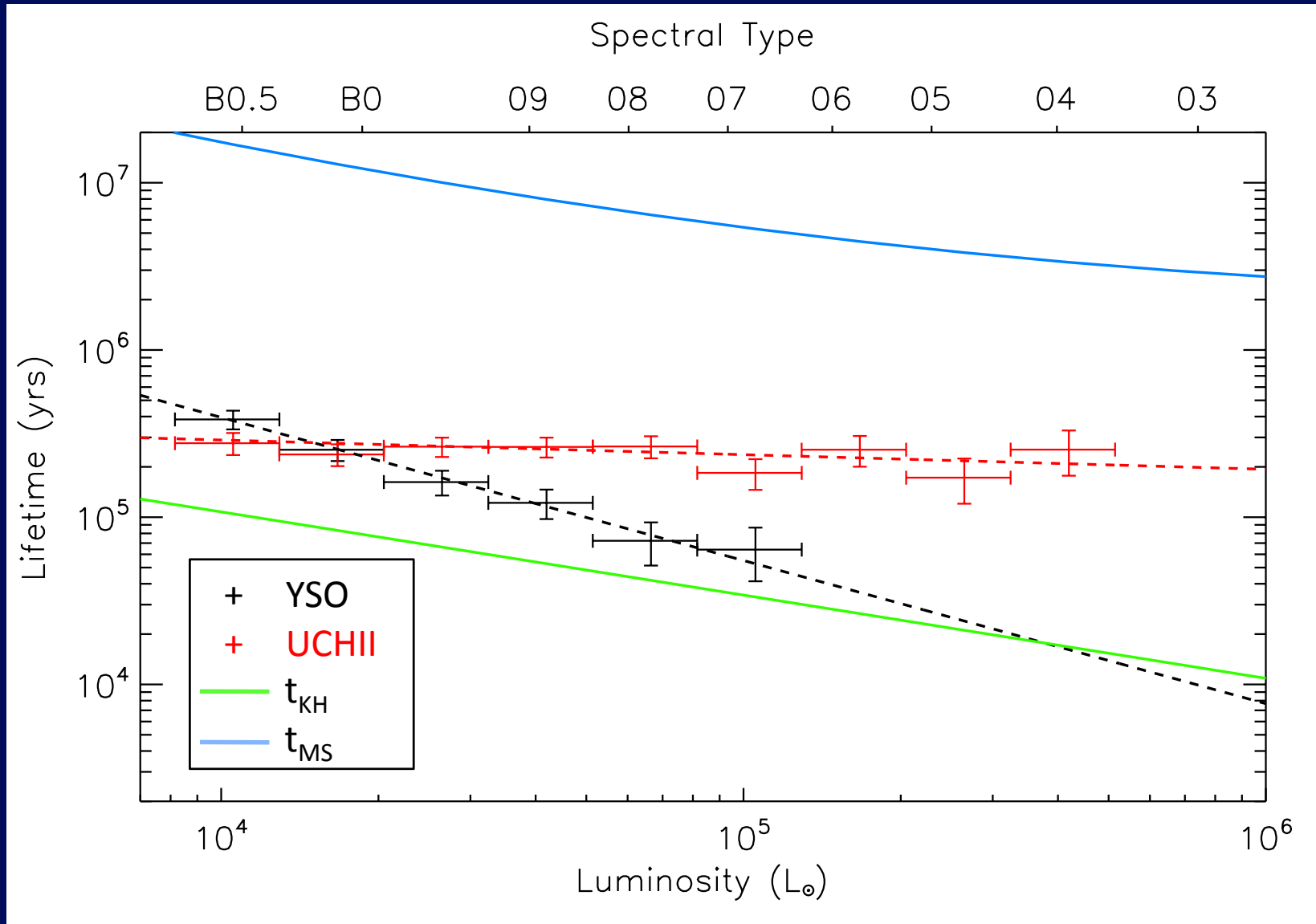




# The Luminosity Functions

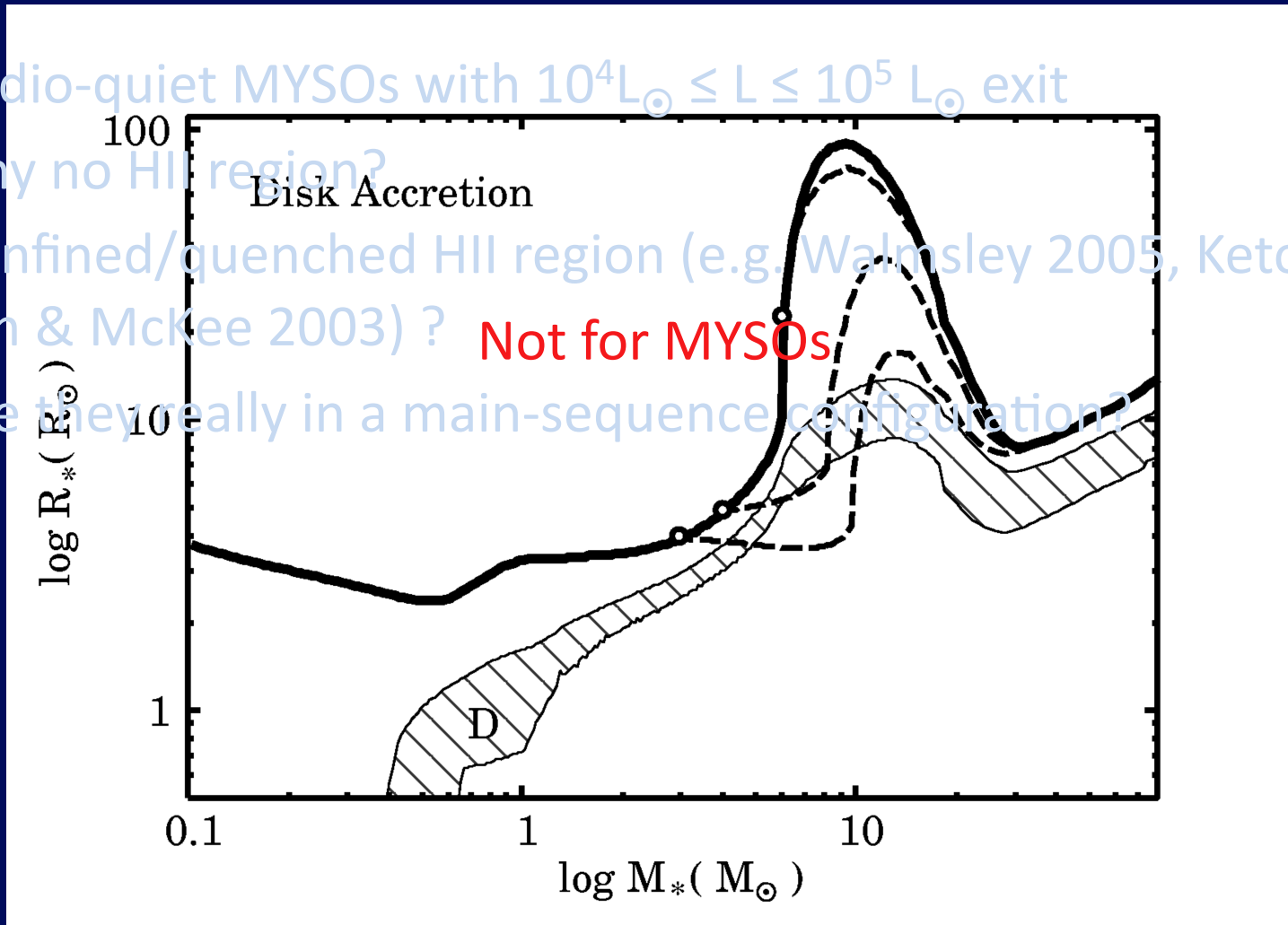


# Timescales



# MYSOs vs HC/UCHIIs

- Radio-quiet MYSOs with  $10^4 L_{\odot} \leq L \leq 10^5 L_{\odot}$  exit
- why no HII region?
- Confined/quenched HII region (e.g. Walmsley 2005, Keto 2003, Tan & McKee 2003) ? **Not for MYSOs**
- Are they really in a main-sequence configuration?



Hosokawa, Yorke & Omukai, 2010

# Summary

- The RMS survey has a sample of MYSOs and UCHII regions
- We have obtained the Luminosity function and timescales for these phases of massive star evolution for the first time
- No MYSO phase for  $L > 10^5 L_{\odot}$  - go straight to HC/UCHII region
- For  $10^4 L_{\odot} - 10^5 L_{\odot}$ , results consistent with swollen cooler MYSOs due to high accretion
- Data available at <http://www.ast.leeds.ac.uk/RMS/>